The trouble with zircon

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A great deal of our understanding of the evolution of the Earth's upper crust comes from studying radiogenic isotope ratios, mainly in zircon [1][2]. The study of detrital zircon populations for provenance and geochronology has become standard practice and while methodology is still decidedly contentious [3], the interpretation of resultant data are often riddled with additional challenges when resolving the geological scenario [4][5].

A study of various lithotypes from ambiguous sedimentary successions spanning the Cambrian divide, and associated with SW Gondwana evolution, tested the applicability of detrital zircon dating in resolving geological problems. A combination of U-Pb and Lu-Hf isotope analysis on detrital zircon using LA-ICP-MS was applied to establish depositional timing and history, as well as gain insight to crustal evolution of particular regions in southern Africa, Spain and Argentina. Here, the effect of tectonic setting and sedimentary processes on sediment accumulation was explored. In addition, the relationship between the maximum depositional age revealed by zircon analyses and other depositional constraints was compared.

Results substantiate the bias in the detrital record between tectonic settings: zircons tell the story of arcs and orogens, while identifying rifts and interpreting periods of tectonic inactivity are more ambiguous [6][7]. More importantly, bias may be further constrained at a facies level. In particular, sedimentary and structural factors are not always apparent, especially in poorly preserved paleo-environments. However, these are shown to greatly impact zircon grain input and preservation – with important implications for paleogeographic reconstructions.

Detrital zircon as a measure of maximum depositional age is useful but often problematic, leaving interpretation open ended in many instances. One particular issue is identifying ancient Pb-loss, which may be solved by combining U-Pb and Lu-Hf isotope systematics.

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